4.5 TRANSITION SUBCOMMITTEE SUMMARY

Overview and General Observations

4.5.1 The Transition Subcommittee (TRSC) pursued a strategy for moving to the environment recommended by the other subcommittees. Emphasizing the issues raised in the FCC's refarming docket,[22] the subcommittee considered proposals addressing the proceeding's goal of migrating toward greater efficiency and enhanced services.

Recommendations

4.5.2 The FCC, in the refarming proceeding, promulgated rules directed toward obtaining increased efficiencies in spectrum below 512 MHz by private land mobile radio users, including Public Safety. The FCC established a new channel structure that embraced narrowband technologies via reduced channel spacing or equivalent spectral efficiency approaches. The subcommittee, in supporting all reasonable requirements to move rapidly toward more efficient spectrum technology, believes that doing so through the FCC's policy of type acceptance of new equipment may not be sufficient. Under type acceptance, only equipment embracing particular spectrum efficiencies would be accepted as of a certain date. Existing equipment would not be precluded from use. The imposition of a date certain for all equipment conformance should be considered, with the subcommittee recommending that urban areas convert to the new efficiency standards by 2005.

4.5.3 The Transition Subcommittee report addressed the merits of Public Safety agencies receiving an exclusive license for "Protected Service Areas" that embrace an agency's area of jurisdiction. Generally, Public Safety shares its spectrum. Notably, agencies essentially operate in a "de facto exclusivity" environment, through the frequency coordination process, where users are provided the largest degree of channel exclusivity possible to ensure channel availability in emergent circumstances. Non-interference is essential to vital communications. The subcommittee recommends that Public Safety agencies be permitted to convert their shared licenses to exclusive system licenses. An exclusive environment will not have to accommodate the potential for interference from shared users, which the subcommittee believes undermines any commitment to investing in advanced technologies. Obtaining exclusivity would be conditioned on committing to advanced technologies.

4.5.4 In the subcommittee's view, technical standards need to be developed for the migration to the more efficient technologies envisioned by the FCC's refarming docket. Providing a means to measure compatibility between various technologies and actually obtain efficiency is crucial. The benefits to be gained through refarming can only come about through coordination with adjacent license holders. The subcommittee recommends that an initiative undertaken by APCO and LMCC, in requesting TIA to

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22 *Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services*, P.R. Docket No. 92-235, 10 FCC Rcd 10076(1995).

facilitate the accommodation of advanced technologies in a post refarming environment, be embraced. The subcommittee urges the FCC to seek comment on the validity of using TIA to establish the necessary parameters for the new environment.

4.5.5 The subcommittee recommends that Public Safety allocation and administration policies below 512 MHz remain as currently established, that the separate service allocations continue and the current method of frequency coordination be retained with the present coordinators. If present service pools are consolidated, the subcommittee recommended that three categories be established. These are 1) Public Safety, 2) Public Services, and 3) Business/Commercial, with the Public Safety frequencies identified by service. The services should be ranked according to their relative importance in performing essential Public Safety responsibilities and preserving the nation's infrastructure. Interservice sharing should be authorized only from higher ranked to lower categories, except in shared systems. Any consolidated pool should be serviced by the present coordinator. In the context of FCC licensing processes, the subcommittee urges consideration of assigning more authority and responsibility to frequency coordinators. Additionally, the subcommittee urges that more extensive electronic filing and processing be adopted.

4.5.6 The Transition Subcommittee urged greater effort toward the development of shared federal, state and local systems that facilitate closer cooperation between all levels of government. The expansion of large wide area land mobile communications systems would bring enhanced capability to all levels of government. The subcommittee noted that spectrum efficiency can be increased through spectrum sharing by multiple Public Safety agencies. Intensive regional planning for congested areas is an important element in this regard, with more generic plans for rural and less congested areas. The subcommittee would oppose linking access to any additional spectrum contingent on such planning efforts, however.

4.5.7 In addressing the issue of block licensing to states, the subcommittee noted that structures should be embraced that bring about state and local planning, ownership and operation of systems, where all users have an incentive to approach spectrum efficiency and enhanced services. Shared state or wide area systems are reflective of this goal. In this sense, spectrum management roles for state or political subdivisions must be reviewed carefully. The subcommittee recommended that the FCC remain the final arbiter of any dispute involving non-federal use of the spectrum by Public Safety.

4.5.8 In urging improved coordination between non-federal and federal Public Safety officials, the Transition Subcommittee noted that there are significant inefficiencies brought about by the separate and distinct licensing responsibilities. Improved coordination, or convergence of these functions under one regulatory structure, is recommended. Moreover, shared federal, state, and local systems would facilitate close cooperation and provide a broadened resource support base.

4.5.9 The subcommittee evaluated funding alternatives, including several traditional areas. It suggested that Congress and the FCC consider designating monies from the revenues

raised from spectrum auctions be committed to interoperability efforts. Any scenario where Public Safety relinquishes spectrum and relocates, must be premised on all the costs of moving to and operating in other spectrum being paid.

5. GLOSSARY

Additive White Gaussian Noise (AWGN)

Noise whose spectrum is "flat", that is, constant as a function of frequency. It is characterized by an autocorrelation function that is a Dirac delta function.

Amplitude Modulation (AM)

Process in which the amplitude of a carrier is varied about a mean value, linearly with a base band signal.

Analog Modulation Technique (*e.g.*, FM)

Process whereby message signal, which is the analog of some physical quantity, is impressed on a carrier signal for transmission through a channel.

Auto-Aid

A concept in dispatching in which the closest available unit to an incident regardless of jurisdiction, is sent to a scene. This concept is beginning to take hold in the law enforcement community. Auto-aid is a preplanned response; it is not called for by an on-scene incident commander.

Automatic Repeat reQuest (ARQ)

Data networks often provide return receipts back to the originator when the data is successfully delivered, coupled with repeated transmissions from the originator as needed. These are generally referred to as Automatic Repeat reQuest, or ARQ.

Availability

Generally descriptive of the percent of time that a radio channel is available for use when needed.

Broadband Data Systems

Form of data communications where several subscribers share and can simultaneously use one common communications line. Each subscriber's data are modulated over a carrier frequency, i.e., information is frequency-division multi-plexed. Generally, in contrast to baseband communications.

Busy

The time waiting for a busy channel to become available in trunking systems. This is typically expressed as the average waiting time for only those occurrences where a busy condition occurred.

Clarity

The ability to recognize the individual speaking.

Code Division Multiple Access (CDMA)

A channel access method in which all conversations are separated by code space. CDMA is employed for widest-bandwidth in both single system applications such as cellular as well as distributed uncoordinated applications such as the Industrial, Medical, and Scientific band (ISM).

Command Post

Designated as the CP, the Command Post is be the location from which all incident operations are directed. There normally should only be one Command Post for an incident.

Compandored Single Side Band

Form of amplitude modulation in which only the upper sideband or lower sideband is transmitted. The compandor is used to reduce the level of strong talk spurts at the head end of the system without exceeding the system design level.

Conventional Voice and Data Systems

Systems where a single channel or a pair of channels is employed, which may require an end user to wait for a break to seize the channel.

Delay

Generally descriptive of (1) the time between when a radio channel is needed to when it is available, (2) the lag between when it is available to when it can begin serving useful communications, as well as (3) the start-up character of the service.

Delivered Audio Quality

The principal metric involves recipient understanding and whether or not repetition is required. This metric is called Delivered Audio Quality and consists of a 5 point scale. The lowest value is one, referring to the worst case where the message in unreadable and therefore unusable. The highest is five, where speech is easily

understood , no repetition is necessary and noise or distortion components are not introduced in the communications channel. The intermediate values range in the ease of understanding and the frequency of repetition required as well as the nuisance contribution of noise and distortion components introduced along the way.

Digital Modulation Technique

Technique for placing a digital data sequence on a carrier signal for subsequent transmission through a channel.

Encryption

The process of scrambling or rendering transmissions unintelligible except to authorized listeners. Encryption is applicable for data transmissions in the same manner as for voice. Although the numeric representation of data is not intended to be converted into meaningful speech, the goal of data encryption is to prevent the unintended reception from being converted back into the data's original form.

Erlang Theory

Measure of telephone traffic load expressed in units of hundred call seconds per hour (CCS). One erlang is defined as the traffic load sufficient to keep one trunk busy on the average and is equivalent to 36 CCS.

Error Control (ARQ)

Error control refers to the same numerical techniques of error correction and error detection as described for voice. Data networks often provide return receipts back to the originator when the data is successfully delivered, coupled with repeated transmissions from the originator as needed. These are generally referred to as Automatic Repeat reQuest, or ARQ.

Fast Forward Signal Regeneration (FFSR)

Provides the ability to receive a correct message even in the presence of transmission errors. Is used for improving the performance of TTIB.

Forward Error Correction (FEC)

Provides the ability to receive a correct message even in the presence of transmission errors.

Frequency Division Multiple Access (FDMA)

A channel access method in which different conversations are separated onto different frequencies. FDMA is employed in narrowest-bandwidth, multi-licensed channel operation.

Frequency Modulation (FM)

Form of angle modulation in which the instantaneous frequency is varied linearly with the baseband signal.

Helibases

Helibases are locations in and around the incident area at which helicopters may be parked, maintained, fueled, and loaded with personnel or equipment. More than one Helibase may be required on very large incidents.

Helispots

Helispots are more temporary and less used locations at which helicopters can land and take off.

Incident Base

The Incident Base is the location at which primary support activities are performed. The Base will house all equipment and personnel support operations. There should only be one Base established for each incident, and normally the Base will not be relocated.

Incident Command System (ICS)

The ICS is a standardized method of operation for Public Safety agencies during large-scale emergency incidents. It has a hierarchical structure which identifies lines of reporting (communications) throughout the organization.

Infrastructure Dependent

The communications link requires the use of some items(s) of equipment, other than a subscriber unit, for establishment of the link and for complete subscriber operation. Some examples include a communications link for which a repeater station is required; a communications link which provides full system coverage for a visiting subscriber unit within a host trunked radio system; and a communications link which provides interconnectivity between two or more otherwise incompatible radio systems by cross-connecting the audio signals and/or appropriate signaling functions at some central point.

Interoperability

An essential communication link within Public Safety and public service wireless communications systems which permits units from two or more different agencies to interact with one another and to exchange information according to a prescribed method in order to achieve predictable results.

Latency

In-to-out delay for an established channel. While analog was real-time, digital processing, transmission, blocking, vocoding, and other factors can produce higher latency.

Linear Modulation

Modulation technique in which the modulated carrier is a linear function of the message signal.

Message/file size

In data communications, the quantity of data to be transmitted via data communication is the first order differentiation of the type of data. The reliability goal for data is not to deliver as reliable a signal as possible in real time, but instead to deliver 100% error free data in as little time as possible. To this extent, data reliability generally refers to two separate attributes: (1) the percent of data that is not deliverable, and (2) the percent of data that is delivered with undiscovered error. The former may often be referred to as **reliability** while the later is often referred to as **falsing**.

Mission Critical

A mission critical communication is that which must be immediate, ubiquitous, reliable and, in most cases, secure. Mission critical communications require the highest level of assurance that the message will immediately be transmitted and received regardless of the location of the operating units within the designed coverage area. In such cases, system set-up or processing delays are unacceptable and coverage must extend to the operating location of the field units. Most public safety systems that are built for mission critical applications, are designed with extreme care to assure reliable operation in the face of a series of potential system element failures.

Model of Spectrum Demand (Spectrum Requirements Subcommittee)

Spectrum demand is modeled by relating the predicted user population, service penetration, offered load (*i.e.*, demand), transmission content requirements, coding efficiencies, transmission rate, error control and overhead requirements, channel loading limitations, and geographic re-use factors.

Multi-disciplinary

Wireless communications involving two or more different agencies. Some examples include a police agency communicating with a fire agency and a parks agency communicating with an emergency medical services agency.

Multi-jurisdictional

Wireless communications involving two or more similar agencies having different areas of responsibility. Some examples include a fire agency from one city communicating with a fire agency from another city and the Federal Bureau of Investigation (FBI) communicating with a County Sheriff.

Multi-site Simulcasting

Used in "trunked" or conventional radio systems to cover wide areas or areas which are difficult to cover with normal radio transmission methods. Multiple transmitters are used on the same frequency and are synchronized by a common time or frequency standard architecture.

Nyquist Sampling

Lowest rate at which a finite-bandwidth signal can be periodically sampled in order to reproduce the signal completely and faithfully. The Nyquist rate is equal to twice the bandwidth of the signal.

Over-The-Air-Rekey

Where cryptographic protection is employed, federal, Department of Defense, state and local agencies require user friendly electronic key variable dissemination and management. Terms such as Over-The-Air-Rekey (OTAR) are often used to describe this process, often in conjunction with multi-key, which refers to the use of multiple cryptographic keys to facilitate interoperability.

Public Safety

The public's right, exercised through Federal, State or Local government as prescribed by law, to protect and preserve life, property, and natural resources and to serve the public welfare.

Public Safety Services

Those services rendered by or through Federal, State, or Local government entities in support of public safety duties.

Public Safety Services Provider

Governmental and public entities or those non-governmental, private organizations, which are properly authorized by the appropriate governmental authority whose primary mission is providing public safety services.

Public Safety Support Provider

Governmental and public entities or those non-governmental, private organizations which provide essential public services that are properly authorized by the appropriate governmental authority whose mission is to support public safety services. This support may be provided either directly to the public or in support of public safety services providers.

Public Services

Those services provided by non-public safety entities that furnish, maintain, and protect the nation's basic infrastructures which are required to promote the public's safety and welfare.

Rayleigh Multipath Fading

In a flat fading mobile radio channel, where either the transmitter or the receiver is immersed in cluttered surroundings, the envelope of the received signal will typically have a Rayleigh distribution. Fading is caused by wave interference between two or more multipath components that arrive at the receiver while the mobile travels a short distance (a few wavelengths) or over a short period of time.

Resolution

Expressed as image dimensions in terms of pixels, which each represent one PIXture cELl or dot. Any given image can variably be represented in higher resolution by using more pixels, resulting in a larger digital representation. Conversely lower resolution using fewer pixels results in a smaller digital representation.

Set-up

The time necessary to make a channel available for service. The time waiting for a busy channel to become available is not included.

Staging Area

Staging Areas are established for temporary location of available resources. Staging Areas will be established by the Operations OIC to locate resources not immediately assigned. A Staging Area can be anywhere in which personnel and equipment can be temporarily located awaiting assignment. Staging Areas may include temporary

sanitation services and fueling. Feeding of personnel would be provided by mobile kitchens or sack lunches. Staging Areas should be highly mobile.

Time Division Duplexing multiple access (TDD)

A channel access method in which a single radio channel is shared in time to achieve full duplex operation. TDD is employed to achieve full duplex operation in a single radio channel.

Time Division Multiple Access (TDMA)

A channel access method in which different conversations are separated into different time slots. TDMA is employed in exclusive license use, moderate bandwidth applications.

Transparent Tone In Band (TTIB)

Applies corrections to the received signal as necessary to produce known pilot tone characteristics, and thus correct the accompanying information signal.

Truncation

The amount of speech lost between when a voice service is requested to when it is set-up and conveying speech. Digital technology may trade-off truncation for latency.

Trunked Systems

Systems where multiple channel pairs are integrated into a single system. When a user wants to transmit a message, the trunked system will automatically select a currently unused channel pair and assign it to the user, decreasing the probability of having to wait for a free channel for a given channel loading.

Tone Above Band (TAB)

Similar to TTIB, but with the pilot tone placed above the information signal instead of at its center.

Type Acceptance

Under type acceptance, only equipment embracing particular spectrum efficiencies would be accepted as of a certain date.

Voice Encoder (vocoder)

The device used to convert the analog voice waveform to a numeric representation is called a vocoder, which is shorthand for VOice CODER.

Department of Administrative Services

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September 3, 1996

Phil Verveer
Willkie Farr and Gallagher
1155-21st Street NW
Washington DC 20036

Dear Phil:

I want to take this opportunity to applaud the Federal Communications Commission and The National Telecommunications Information Agency for the formation, support, and leadership in the Public Safety Wireless Advisory Committee. They have demonstrated foresight and determination in recognition of the spectrum needs of Public Safety Providers across this nation. I would express my appreciation for your service as the Chairman and commend you on the fine and diligent manner with which you brought this report to fruition. I also wish to extend a vote of thanks to the sub-committee chairpersons and committee members who have put forth a great effort to provide input into this document. These persons and the agencies they represent are to be commended for supporting this year long process.

This has been an exhaustive effort. We have adequately documented and defined the Public Safety Communications Spectrum Requirements for the next 15 years. It is my feeling that the document is very reflective of input from a broad base group of users including Federal, state, local government and commercial interests. This fact lends great credibility to the report.

It would be my further recommendation that the Federal Communications Commission and National Telecommunications Information Agency make implementation of these recommendations their first priority. It is imperative to

keep the momentum going with regards to public safety issues. These findings and recommendations give the public safety community, for the first time, an opportunity to begin planning for future systems with knowledge that the spectrum they need will be available to accomplish their goals. The citizens of this country will certainly benefit from the process.

I thank you for the opportunity to serve with you on the Steering Committee. If there is anything I may do, please feel free to contact me.

Sincerely,

Steve Proctor

Steven H. Proctor
Steering Committee Member

VOLUME II

This *Final Report* of the Public Safety Wireless Advisory Committee is divided into two volumes.

Volume I contains the main body of the report, including summaries of the various subcommittee reports.

Volume II contains the full text of the subcommittee reports along with their supporting documents, where available.

6. INDEX TO APPENDICES:

PLEASE NOTE:

The following subcommittee reports are included in as much of their entirety as possible owing to the availability of electronic versions of some of the supporting documents. Where an electronic version was not available, it has been so noted and the reader has been referred to the appropriate FCC Docket, where the full text of all information relating to PSWAC is contained. The only changes to the subcommittee documents that have been made relate to formatting such as fonts and margins used in order to provide consistency throughout the PSWAC document. It should also be noted that some of the following subcommittee reports contain a Table of Contents with page numbers. These page numbers are not necessarily accurate due to the above formatting changes, however, none of the contents of the subcommittee reports have been changed, including their referenced page numbers.

6.1 APPENDIX A - Operational Requirements Subcommittee Report

FINAL REPORT

OPERATIONAL REQUIREMENTS SUBCOMMITTEE

PRESENTED TO

PUBLIC SAFETY WIRELESS
ADVISORY COMMITTEE

NATIONAL TELECOMMUNICATIONS AND
INFORMATION ADMINISTRATION

FEDERAL COMMUNICATIONS COMMISSION

As Submitted July 12, 1996

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This document constitutes the report of the Operational Requirements Subcommittee, Public Safety Wireless Advisory Committee, regarding operational requirements for the public safety communications community nationwide through the year 2010. With respect to each functional area of public safety communications, the report catalogs requirements according to the general nature of the information to be communicated. In addition, subcommittee observations and recommendations regarding current shortfalls, sharing of resources and interoperability issues are noted for such use as the other subcommittees may deem appropriate.

2.0 OPERATIONAL REQUIREMENTS SUBCOMMITTEE OVERVIEW

2.1 COMMITTEE OBJECTIVES & ORGANIZATION

The Public Safety Wireless Advisory Committee (the "Advisory Committee") was established in response to provisions of Title VI of the Omnibus Budget Reconciliation Act of 1993 directing that the Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA) coordinate more closely with the public safety community in planning for future spectrum needs.

The general mission of the Advisory Committee is to provide advice and recommendations to the Chairman, FCC and the Administrator, NTIA on operational, technical, and spectrum requirements of federal, state, and local public safety entities through the year 2010.

The Advisory Committee also is to advise the FCC and NTIA of opportunities for improved spectrum utilization and efficiency, facilitate negotiated rule making at the FCC regarding public safety spectrum, and support development and implementation of plans at NTIA regarding federal public safety spectrum policy.

Based on the assigned mission, the Advisory Committee elected to form five subcommittees. The four subcommittees other than Operational Requirements and their missions are as follows:

The Interoperability Subcommittee is charged with the mission of examining interoperability requirements between and among the various public safety entities, and reducing them to writing. All phases of interoperability, including command and control, are to be examined.

The Technology Subcommittee is charged with the mission of reviewing technology presently implemented, projected technology implementations, and trends in wireless technology. The subcommittee is expected to identify technologies related to each operational need and determine bandwidth required to meet that need. The Technology Subcommittee also is expected to identify spectrum limits for each bandwidth identified.

The Spectrum Subcommittee has the mission of taking the bandwidth and spectrum placement recommendations and recommending a spectrum allocation plan. The plan is expected to include current spectrum assignments and recommendations with regard to future allocations. A timetable is to be developed by the subcommittee based on recommendations received from the Transition Subcommittee.

The Transition Subcommittee has the mission to consider how to implement the new technologies and services in a timely, rational manner. Issues to be considered by this subcommittee include funding methods, migration plans, and time tables.

2.2 CHARTER OF THE OPERATIONAL REQUIREMENTS SUBCOMMITTEE

The general mission of the Operational Requirements Subcommittee (the "Subcommittee") is to enumerate the communication needs of the public safety community without regard to specific technology or spectrum. The needs are to be classified as to the type of service (e.g., real-time, full-motion video) and quantity of service (number of channels, e.g., two full-time video channels in every city, one for EMS use and one to be shared between fire and police). Each need additionally is to be prioritized as to necessity for proper functioning of the public safety community.

2.3 SCOPE OF THE SUBCOMMITTEE REPORT

This report of the Subcommittee is intended to provide a snapshot of operational capabilities that must be considered in the overall planning process. The Subcommittee also has examined operational requirements that are unmet or suffer from reliability, quality, or coverage deficiencies. This report of the Subcommittee will be forwarded to the Technology and Interoperability Subcommittees. Requirements for interoperability identified by this Subcommittee will be forwarded to the Interoperability Subcommittee for consideration.

Many public safety entities and organizations provided comment regarding the issues encompassed in the responsibilities of the Subcommittee. In many cases the comments received included topics outside the scope of the Subcommittee charter. The following limitations were observed in preparing this report.

Several comments included specific suggestions regarding the number of channels that should be devoted to particular applications in the commenting agency's particular geographic area of responsibility. The Subcommittee has elected not take a position on issues of spectrum allocation in particular jurisdictions. As a part of its charter, the Subcommittee does have the requirement to provide quantity recommendations of general application, however. Along with other subcommittees, the Operational Requirements Subcommittee therefore provided planning data for use in the quantity model developed with the assistance of engineers from Motorola. Further information regarding this quantity model and the Subcommittee's input is provided at Annex B. In addition, the Subcommittee identified basic quantity recommendations for certain common user lines of communication described in the narrative of the report. Finally, the Subcommittee has in the course of its work attempted to identify the basic complement of communications support that must be maintained by any jurisdiction

that provides the various public safety services involved in this report, along with priorities appropriate to each type of support. The priorities indicated should not be interpreted as indications the public safety community does not consider any indicated requirement essential to maintenance of the public's safety. Every requirement indicated in this report is deemed essential to the public safety mission. Priorities are intended only to indicate the comparative importance of each requirement.

Several comments included specific suggestions regarding the frequency range appropriate for particular requirements. The Subcommittee position is that issues of spectrum use fall within the purview of the Spectrum Requirements and Technology Subcommittees. No recommendations or commentary are included in this report regarding appropriate frequencies.

A few comments were received suggesting that the Subcommittee study and include in its report a catalog of specifications that equipment, for example portable radios, should meet in order to be suitable for public safety use. The Subcommittee considered performing such a study incident to its work, but concluded this topic was not germane to the basic mission of the Subcommittee and the Advisory Committee, which is oriented on spectrum.

3.0 SUBCOMMITTEE ORGANIZATION

3.1 DEFINITION OF PUBLIC SAFETY

At the first meetings of the various subcommittees conducted in Washington, D.C. on September 29, 1995, considerable discussion occurred regarding the definition of "public safety" for purposes of the Advisory Committee. For purposes of this report, the Operational Requirements Subcommittee initially elected to use a very expansive definition, with the understanding that the Advisory Committee might at some future time adopt a less expansive definition for its purposes. The Subcommittee's initial approach was based on two observations. First, the Subcommittee recognized that although a particular constituency's primary business might not fall within a classic public safety definition, aspects of its operations could involve or impact matters of public safety. Second, the Subcommittee recognized that by providing an expansive catalog of requirements from the various constituencies, other subcommittees and ultimately the Advisory Committee would benefit from a broad perspective in determining precisely what requirements should be accommodated when spectrum and other issues are addressed.

Following adoption of definitions of public safety and related matters, the scope of the Subcommittee report was again discussed at the Berkeley meeting. At that time, the Subcommittee elected to include in this report and note its support for the definitions adopted by the Advisory Committee which follow:

Public Safety: The public's right, exercised through Federal, State or Local government as prescribed by law, to protect and preserve life, property, and natural resources and to serve the public welfare.

Public Safety Services: Those services rendered by or through Federal, State, or Local government entities in support of public safety duties.

Public Safety Services Provider: Governmental and public entities or those non-governmental, private organizations, which are properly authorized by the appropriate governmental authority whose primary mission is providing public safety services.

Public Safety Support Provider: Governmental and public entities or those non-governmental, private organizations which provide essential public services that are properly authorized by the appropriate governmental authority whose mission is to support public safety services. This support may be provided either directly to the public or in support of public safety services providers.

Public Services: Those services provided by non-public safety entities that furnish, maintain, and protect the nation's basic infrastructures which are required to promote the public's safety and welfare.

3.2 WORKING GROUPS

The Subcommittee elected to form seven working groups. The working group designations, along with their general areas of focus, are described as follows. Order of appearance in this report should not be considered any indication of priority as among the various working groups.

(1) Transport Mechanisms. Initially this working group was designated as the Infrastructure working group. At the Berkeley meeting, its title was changed to Transport Mechanisms to more accurate reflect the scope of its mission. The mission of the Transport Mechanisms working group is to catalog operational requirements for infrastructure communications needed to support other identified public safety communications requirements at federal, state and local levels.

(2) Criminal Justice. Initially this working group was designated the Law Enforcement working group. At the Scott Air Force Base meeting, its title was changed to Criminal Justice and the operational requirements for corrections were placed within the group's responsibilities. The mission of the Criminal Justice working group is to catalog operational requirements for law enforcement and corrections organizations at federal, state and local levels.

(3) Fire, Emergency Medical and Related Life and Property Protection Services. The missions of the Fire, Emergency Medical and Related Life and Property Protection Services working group is to catalog operational requirements for fire and EMS organizations at federal, state and local levels.

(4) Emergency Management and Disaster Services. The mission of the Emergency Management and Disaster Services (EMD) working group is to catalog operational

requirements for emergency management and disaster services at the federal, state and local levels.

(5) Public Service. The mission of the Public Service working group is to catalog operational requirements for public service entities at federal, state and local levels.

(6) Other. The mission of the "Other" working group is to catalog operational requirements for Highway Maintenance, Forestry, General Government, and Mass Transit organizations at federal, state and local levels. At the subcommittee meeting conducted in Berkeley, it was agreed that the Other working group's portion of the report should be separated into areas specific to the organizations involved, i.e. Highway Maintenance, Forestry, General Government and Mass Transit. This separation is reflected in the organization of the final subcommittee report.

(7) Matrix Refinement and Report. The mission of the Matrix Refinement and Report working group initially was development of a common matrix of data required to describe each operational requirement. As the subcommittee's deliberations continued, it became clear this initial matrix would not be required, and it therefore is not included in this report. This working group also was responsible for preparation of this report.

As the Subcommittee continued its deliberations, it became clear that additional working groups would be required in order to adequately capture the operational requirements of all interested public safety constituencies. Accordingly, working groups for federal requirements and intelligent vehicle and highway systems (IVHS) requirements were included in the Subcommittee's deliberations and report.

In addition to the work of the groups described above, the Subcommittee examined quantity and quality aspects of the operational requirements for public safety wireless communications. Quality aspects of these requirements are discussed in Annex A of the report. Quantity aspects of these requirements are reflected in the working group inputs to the planning model adopted by the various subcommittees in order to assist in projecting spectrum requirements. The working group inputs from this Subcommittee are included as Annex B of the report.

3.3 COMMITTEE DELIBERATIONS

An organizational meeting of the Subcommittee was conducted September 29, 1995 in Washington, D.C. At that meeting, discussion was conducted and consensus reached regarding the subcommittee mission and the public safety functional areas to be examined. Consensus also was formed regarding the working groups necessary to accomplish subcommittee purposes. An initial discussion was conducted regarding the composition of a matrix to be used to catalog each operational requirement identified by the working groups. Following the September meeting, work was completed on a draft version of the matrix.

The subcommittee met again on October 26, 1995 at Camp Dodge, outside Des Moines, Iowa. The principal matter on the agenda was review of the draft matrix. Considerable

discussion ensued, resulting in refinement of the matrix for use by the various working groups. Following the October meeting, the matrix was revised to reflect subcommittee deliberations and distributed to working group leaders. Working group leaders began formulating their proposals of operational requirements in each of the functional areas represented by the groups.

A special meeting was conducted in San Bernardino, California on November 17, 1995. Federal budget issues precluded attendance by a Designated Federal Officer, so the meeting was conducted as an informal review of subcommittee activities and progress. Considerable, wide-ranging discussion occurred. Attendance was heavily weighted toward users, suggesting that additional meetings in other regions of the United States would benefit the various subcommittees.

A regular meeting of the Subcommittee was conducted in Washington, D.C. on December 13, 1995. Interim reports were presented by the various working group chairs regarding their progress to date. A status report regarding the Subcommittee's activities was presented to the Advisory Committee at its regular meeting conducted December 15, 1995. Following the December 13th meeting, working group leaders continued work on their narratives of operational requirements. Their work was provided the Matrix Refinement & Report working group, which incorporated it in this report.

Additional regular meetings of the Subcommittee were conducted in Berkeley, California on January 10, 1996, Orlando, Florida on February 28, 1996, and San Diego, California on April 11, 1996. Copies of the draft report of the Subcommittee were made available to attendees at each meeting, and comments regarding its content were received. Following each meeting, revisions were made to the report to reflect the consensus of meeting attendees and those who commented by other means.

A regular meeting of the Subcommittee was conducted at Scott Air Force Base, Illinois on May 29, 1996. Copies of the final draft report of the Subcommittee were made available to meeting attendees, and comments regarding its content were received. Following the meeting, revisions were made to reflect consensus of meeting attendees.

A regular meeting of the Subcommittee was conducted at Washington, D.C. on June 26, 1996. Comments were received regarding the content of the report. As revised following this meeting, the report narrative is considered complete.

4.0 WORKING GROUP REPORTS

This section of the report of the Subcommittee is a discussion of the operational requirements identified by each working group. In each case, the working group report is intended to present each operational requirement from the user point of view, categorized by the nature of the information to be communicated.

4.1 TRANSPORT MECHANISMS

4.1.1 Mission. The mission of the Transport Mechanisms working group is to catalog operational requirements for communications transport networks and infrastructure at federal, state and local levels.

4.1.2 Introduction. Transport networks consisting of microwave links, satellite links, and leased (copper or fiber-optic) circuits are crucial elements of the infrastructure for routing voice, data and video circuits between communication sites. Wireless links, primarily customer owned microwave networks, have been and will continue to be a primary distribution method for public safety communication systems.

There are also public safety requirements for operational fixed links in the VHF and UHF bands below microwave. Public safety has a definite need for fixed operational links which operate on frequencies between 70 MHz and 470 MHz. In rural mountainous areas high level sites are frequently required to provide wide area system coverage, such as for counties and states. Fixed links are frequently used to give remote base station control. Such links use 72-75 MHz, 150-174 MHz, 406-420 MHz or 450-470 MHz equipment for the link. These links carry signaling and voice to and from the fixed based station. They are necessary because of the unavailability or unreliability of leased control circuits in rural areas. They are also used because they are much more economical than using microwave, and the multi-circuit capability of microwave is not needed. Often there is no line of site between the dispatch or control point location and the base station to allow microwave control; multiple sites often cannot be used because of terrain which may be inaccessible or restricted through wilderness designation, or through unavailability of communications site use through federal agency management on federal lands. The only practical and cost effective solution often lies in the use of single frequency links which can diffract or bend over the intervening terrain. Seventy MHz is ideal for this purpose, but often a high power 450 MHz link may suffice. In some very remote long distance applications, VHF 150 MHz links may also be used. In some state and county low band systems, VHF high band links are frequently used over very long distances. There is also a second use for these lightly loaded, often single channel operational links. They may be used for such purposes as voting receiver connectivity or single transmitter control. Microwave links are not suited for these purposes, because of propagation problems, cost and because there is no need for the number of circuits possible with microwave. It would be very spectrum inefficient as well to use microwave for such very low density requirements. Public safety requires dedicated channels for these low density, control purposes. While this use is infrequent, it is highly important where it is needed. Present channels in VHF are heavily shared and very difficult to keep free of interference because of high channel usage when used as links in base and mobile systems. The 450 MHz 12.5 KHz off set links meanwhile have been converted to full power operation by refarming and their use as links will become difficult to impossible. These requirements must be considered in providing for public safety spectrum needs as there is no other viable solution. Where these links are required, there is no commercial service available to use as an alternative because they are for very remote applications.

Customer owned microwave links have proven to be the most reliable transport networks in disaster situations, such as earthquakes and fires. While fiber optic and copper cables are vulnerable to back hoe, fires and earthquakes, microwave links have survived in most disasters. Microwave links and redundantly configured systems, properly engineered to survive disasters, also provide the high reliability required for day-to-day public safety operations. While common carriers can and often do provide valuable services, there are regulatory and economic constraints that restrict their ability to provide reliability and service restoration at the high level required for many public safety applications. Traditional rate-of-return regulation weakens carriers' economic incentives to innovate and to specialize services for specific customers. Any commercial provider is eager to handle public safety traffic in the lucrative metropolitan areas, but they freely admit they will not provide any service to the remote, low density areas. Traditional common carrier regulation limits carriers' incentives to provide high reliability for specific customers.

Commercial leased lines, however, continue to be utilized in many parts of the country for various reasons. For instance, it is often not economically or physically feasible to install microwave links where the circuit requirement is small or there is no path. For a nationwide or statewide link, it may be cost prohibitive to use microwave. When many circuits are required at one location, large savings are generally realized using customer-owned microwave.

Fiber optic links are also extremely useful in numerous transport applications. The cost and practicality of routing fiber optic or copper circuits to remote public safety communications sites (e.g. mountain tops) can be prohibitive, and as mentioned before not failsafe in case of disasters. Even with high reliability of fiber optics often alternate routing is required to gain the needed reliability and this is frequently very difficult to obtain through that medium. Fiber optics costs, however, continue to drop and fiber will be utilized for many applications. Regardless of whether fiber or microwave is used in high density applications, virtually the same electronic multiplexers are required at each end of the both media. Since electronic devices do occasionally fail, increased reliability is gained through the use of alternate routing. Alternate routing of fiber can be extremely costly because of right of way restraints when feeding multiple sites.

Increasingly, with the advent of Intelligent Transportation Systems (ITS) and other services requiring Dedicated Short Range Communications (DRSC) between infrastructure and public safety vehicles, public safety applications using this technology may occur in much higher frequency ranges as well. These systems may use channels in the microwave range (5.8 GHz) that are being pursued under the ITS program.

4.1.3 Voice Requirements. Just as wireless links are used to transport communications between the roving mobile/portable units and the fixed RF base station sites, wireless infrastructure such as microwave or satellite networks is required to route (analog and/or digital) voice and control messages between the remote RF base station sites and the command/control center. In emergency operation systems, the system operator needs control over the distribution network. As an example, numerous police and fire emergency systems require the use of "multi-site simulcasting" to provide wide area coverage with a minimum